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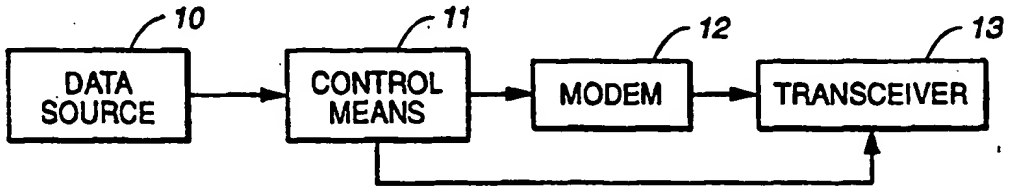
(54) Title: MODEM FOR PACKET AND CIRCUIT SWITCHED COMMUNICATION



(57) Abstract

A method and apparatus for transmitting data over a wireless communication system of either the packet data type or the circuit switched type is provided. A data source (10), such as a personal computer, is connected to a specially adapted modem (12) that is capable of formatting data for transmission over either a packet switched system, such as the CDPD system, or a circuit switched system, such as a conventional cellular telephone system. A control device (11) controls the modem (12) and a transceiver (13), and it determines which communication system is the most desirable. The desirability of the communication system may be based upon cost or quality of the connection which can be established on that particular system.

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MODEM FOR PACKET AND CIRCUIT SWITCHED COMMUNICATION

FIELD OF THE INVENTION

The present invention relates generally to the transmission of data over a wireless communications network and, more specifically, the present invention relates to an apparatus and method for controlling a modem that can be used with either a wireless packet data communication system or a wireless circuit switched communications system.

BACKGROUND OF THE INVENTION

Packet radio communication systems are wireless communications systems for transmitting data or messages. In practice, customers typically access the network through a radio frequency access device that connects the customer's data terminal to a packet switch.

A new wireless packet network called cellular digital packet data (CDPD) is being developed by a consortium of companies including regional cellular operators. The CDPD network, which is different from a conventional cellular telephone system based upon circuit switching, is expected to be a major advancement in wireless wide-area communications. The proponents of the CDPD system envision the base equipment of a CDPD cell being co-located with the base station equipment of a conventional cellular telephone system.

In 1983, the first conventional cellular telephone systems, which were designed according to the Electronic Industries Association's (EIA) interim standard, were put into operation in the United States, and these early systems were known as the Advanced Mobile Phone System (AMPS). The original AMPS system is an analog system in which a plurality of base stations are connected to Mobile Telephone Switching Offices (MTSO) via land lines. The MTSO is in turn connected to the public switched telephone network (PSTN)

via land lines. The base stations transmit information using radio frequency carrier signals within a cell. Mobile stations or cellular telephones operating within a particular base station cell are able to communicate with the base station, and the base station is able to connect the cellular telephone to the PSTN.

It is known that personal computers can be equipped with a specially adapted modem to transmit data over a cellular telephone system. In practice, the personal computer is connected to the special purpose modem which, in turn, is coupled to a cellular telephone via a special connector. A personal computer may also transmit data over a CDPD network using a modem specially adapted for that network. Thus, if the owner of a personal computer wishes to communicate over both networks, the owner must own both a special purpose modem for a cellular telephone system and a special purpose modem for a CDPD network.

SUMMARY OF THE INVENTION

The present invention, generally speaking, provides a method and apparatus for transmitting data or information over either a wireless packet data system, such as a CDPD system, or transmitting data over a wireless circuit switched system, such as a conventional cellular telephone system. More particularly, the present invention provides a method and apparatus that allows data to be transferred over either a wireless packet data system, such as a CDPD system, or a wireless circuit switched system, such as a conventional cellular telephone system, using the same modem. In practice, systems according to the present invention address the combination of wireless packet circuit transmission or conventional cellular telephone transmission using the same radio.

In the preferred embodiment, the present invention includes a data source, such as a personal computer or telemetry device, to generate data. The

data from the data source is applied to a control means that controls a modem and a transceiver. The modem is especially adapted to work with either a CDPD system or a conventional cellular telephone system. The control means is able to select the most desirable system over which a link is to be established. For example, the control means could evaluate the quality of the connection on either system. The control means then establishes a communication link on one system which is determined to be the best, according to some criteria which may be pre-set, selected dynamically by the user or otherwise established.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be further understood with reference to the following description in conjunction with the appended drawings, wherein like elements are provided with the same reference numerals. In the drawings:

Figure 1A is a block diagram of the apparatus of the present invention;

Figure 1B is a block diagram of another embodiment of the present invention; and

Figure 2 is flowchart of the control means of Figure 1A.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figure 1A, a communications system includes a data source 10 which may be a personal computer, telemetry device or other means of generating data. The output from data source 10 is applied to a control means which preferably includes a suitably programmed microprocessor. The control means 11 controls a modem 12 and a transceiver 13. The modem 12 is able to adaptively transmit data over a cellular telephone infrastructure in packet switched form or in circuit switched form. In the packet switched mode, data is transmitted from the data source 10 using the modem 12 which is designed to communicate via suitably modified base station receivers and transmitters as described in, for example, the CDPD specification. In the circuit switched

mode, the same radio is used to transmit data over a conventional cellular telephone system by controlling the radio to transmit and receive necessary signalling information needed to set up or to end circuit connection to a matching modem using, for example, the AMPS protocol in North America or other standards.

The control means 11 is used to determine whether the data to be transmitted from the data source 10 should be sent in packet switched form or circuit switched form based on criteria established either in manufacturing or dynamically by the user. One criterion would be the availability of the packet switched capability in the cellular infrastructure. In the dynamic case, the decision is made by the control means 11 attempting to initiate packet switched communications or by monitoring the radio channel to determine the presence or absence of control signals or traffic patterns associated with a packet communications channel. If the control means 11 determines there is no packet switched capability, then the communications would be initiated by circuit switched means over a conventional cellular telephone system.

The control means 11 also determines whether data can be transmitted in circuit switched form. In practice, the determination is based on the availability of circuit switched capability in the cellular infrastructure which is compatible with the control means. The decision is made by the control means 11 when it attempts to set up a circuit switched connection. In one scenario, the cellular infrastructure is unable to allocate circuit switched capacity (either due to the channels being busy or due to equipment failure or due to the fact that the base station with which the modem is communicating was designed to be "packet only"), then communications would be set up on the packet switched system. In another scenario, the cellular infrastructure does not support the protocol used in the modem (e.g. AMPS), and the modem is incapable of communicating using the protocol supported by the cellular infrastructure (e.g., a digital cellular protocol). In still another scenario, ancillary software resident

in the data source 10 or in the control means 11 determines which means of transmission is best for the data to be transmitted based on the criterion of cost. The ancillary software or the control means may also determine which means of transmission is best for the data to be transmitted based on performance, such as response time, throughput or some other objective criteria.

The system according to the present invention preferably includes an error control strategy which is best for the circuit switched communication mode. This error control strategy can be embedded in the ancillary software of the data source 10 or the control means 11. For example, the CDPD specification specifies one particular form of error control for packet data. There is economy to be gained by using the same error control for circuit switched data where appropriate fixed modems are available for communications. The control means 11 preferably determines whether the fixed modem with which it is attempting to communicate over a circuit switched connection is able to interpret the CDPD error control scheme. If it is, then this would be the error control means of choice. Where it is not, an alternative scheme would be used.

Likewise, an error control strategy which is best for the circuit switched communication is preferably embedded in either the data source 10 or the control means 11. The state of the channel on which communications are occurring would be assessed based on the quality of the most recently received messages, and an adaptive scheme used in which increasing levels of error control are added to subsequent data transmissions. As an example, a high rate (i.e., one with a high ratio of data content to error control overhead, such as without loss of generalities, a rate 3/4 code) could be transmitted in the first transmission. Subsequent transmissions would use lower rate codes,(e.g., without losing generalities, rate 1/2 and 1/4) if difficulty was encountered in the transmissions. The same effect can be obtained by multiple transmissions of higher rate codes provided sufficient means is used to combine the partially

received packets. This technique often referred to as "code combining" provides the advantage of retransmission at lower rates with more efficiency, but at a cost of more receiver complexity.

In Fig. 1B there is a block diagram of an alternate embodiment of the present invention that includes an apparatus 16 having control means 11', transceiver 13, internal modem 14 and switching means 17. The data source 10 and the transceiver 13 are substantially identical to the corresponding components of Fig. 1A. Control means 11' performs functions substantially identical to control means 11 of Fig. 1A, but the control means 11' is capable of controlling the switching means 17. The switching means 17 is used to selectively couple either external modem 15 or internal modem 14 to the input of the transceiver 13. It may not be practical to include an error control scheme in the control means 11' of Fig. 1B, and therefore, the error control scheme should be implemented in either the data source 10 or external modem 15.

Preferably, the internal modem 14 is a packet switched modem that is internal to apparatus 16, and the modem 15 could be a conventional circuit switched modem of the type commonly used in personal computers. The modems 14, 15 essentially perform the same modulating/demodulating functions of modem 12 of Fig. 1A. When the control means 11' determines that packet switched data is to be transmitted or received by the transceiver 13, the switching means couples the internal modem 14 to the transceiver 13. Likewise, when the control means 11' determines that circuit switched data is to be transmitted or received by the transceiver 13, the switching means couples the external modem 15 to the transceiver 13.

In Figure 2, a flow diagram illustrates a representative example of the software that could be used in the control means 11 of Fig. 1A of the present invention.

The software starts at step 20, and in step 21 a determination is made whether a packet data connection is available. In other words, a determination is made whether the apparatus of Figure 1A can gain access to a system such as a CDPD system. If access to the packet data system is available, a determination is performed in step 40 whether there is information to evaluate the cost of the connection. If there is such information, the cost of the packet switched connection is determined in step 43 and a determination is made in step 41 whether there is an ability to evaluate the quality of the connection. If there is no such information, then a determination is made in step 41 whether there is an ability to evaluate the quality of the connection. If such capability exists, the quality of the connection is determined in step 44. If there is no such capability, then a determination is made in step 42 whether there are some other criteria for evaluating the connection. If the capability exists, then the other criteria are evaluated in step 45.

If it is determined in step 21 that a packet data connection is not available, then the present invention makes a determination in step 24 whether a circuit switched connection is available. In other words, a determination is made whether the present invention can gain access to a conventional circuit switched system or cellular telephone system. If access to the circuit switched system is available, a determination is performed in step 50 whether there is information to evaluate the cost of the connection. If there is such information, the cost of the circuit switched connection is determined in step 26 and a determination is made in step 51 whether there is an ability to evaluate the quality of the connection. If there is no such information, then a determination is made in step 51 whether there is an ability to evaluate the quality of the connection. If such capability exists, the quality of the connection is determined in step 27. If there is no such capability, then a determination is made in step 52 whether there are some other criteria for evaluating the connection. If the capability exists, then the other criteria are evaluated in step 53.

If access to a switched circuit or cellular telephone system is not available, in step 24 the control means stops and waits until it is again instructed to determine the availability of either a packet data connection or a circuit switched connection. If both a circuit switched connection and packet switched connection are available, then in step 28 the control means 11 determines which connection is best. The best connection may be a result of the cost or the quality of the connection or a combination of these two factors, or some other factor.

Once the best connection is selected, a link is established to the desired system in step 29. In step 30 a determination of an error control strategy is performed. Once the error control strategy is determined, the transmission of data can begin in step 31. During the course of data transmission the error control correction may be adaptively changed as indicated in step 32. The end of data transmission results in the performance of step 33, and the control means stops operation in step 34 of the flowchart.

The foregoing has described the principles, preferred embodiments and modes of operation of the present invention. However, the invention should not be construed as limited to the particular embodiments discussed. Instead, the above-described embodiments should be regarded as illustrative rather than restrictive, and it should be appreciated that variations may be made in those embodiments by workers skilled in the art without departing from the scope of present invention as defined by the following claims.

What is claimed is:

1. An apparatus for transmitting data from a data source over either a wireless packet data system or a wireless circuit switched system, comprising:

first means for modulating and demodulating the data in at least a first format suitable for communication over the wireless packet data system and in a second format suitable for communication over the wireless circuit switched system;

a transceiver, coupled to the first means, for transmitting and receiving the data over either the wireless packet data system or the wireless circuit switched system; and

means for controlling the first means and the transceiver such that the data is transmitted over a desired system.

2. An apparatus according to claim 1 wherein said means for controlling includes means for error correction.

3. An apparatus according to claim 1 wherein the data source is a computer.

4. An apparatus according to claim 1 wherein the data source is a telemetry device.

5. An apparatus according to claim 1 wherein the desired system has the least connection cost.

6. An apparatus according to claim 1 wherein the desired system has the best connection quality.

7. An apparatus according to claim 1 wherein said first means includes second means for modulating and demodulating the data in at least the first

format suitable for communication over the wireless packet data system, third means for modulating and demodulating the data in the second format suitable for communication over the wireless circuit switched system, and switching means responsive to said control means for selectively coupling either the second means or the third means to the transceiver.

8. An apparatus according to claim 7 wherein said means for controlling includes means for error correction.

9. An apparatus according to claim 7 wherein the data source is a computer.

10. An apparatus according to claim 7 wherein the data source is a telemetry device.

11. An apparatus according to claim 7 wherein the desired system has the least connection cost.

12. An apparatus according to claim 7 wherein the desired system has the best connection quality.

13. A method for transmitting data from a data source over either a wireless packet data system or a wireless circuit switched system, comprising:

modulating and demodulating the data with a modem in at least a first format suitable for communication over the wireless packet data system and in a second format suitable for communication over the wireless circuit switched system;

transmitting and receiving the data with a transceiver over either the wireless packet data system or the wireless circuit switched system; and

controlling the modem and the transceiver such that the data is transmitted over a desired system.

14. A method according to claim 13 which further includes the step of error correction.

15. A method according to claim 13 wherein the control step includes determining which system has the least connection cost.

16. A method according to claim 13 wherein the control step includes determining which system has the best connection quality.

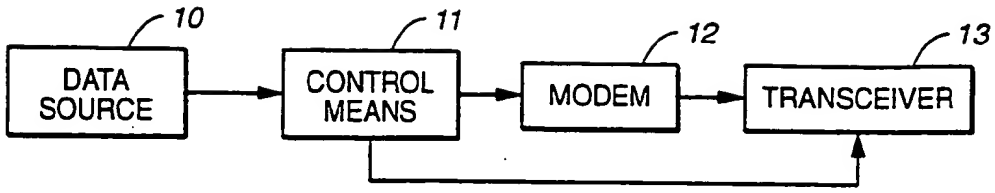
10
11
12
13
DATA SOURCE
CONTROL MEANS
MODEM
TRANSCEIVER

FIG._1A

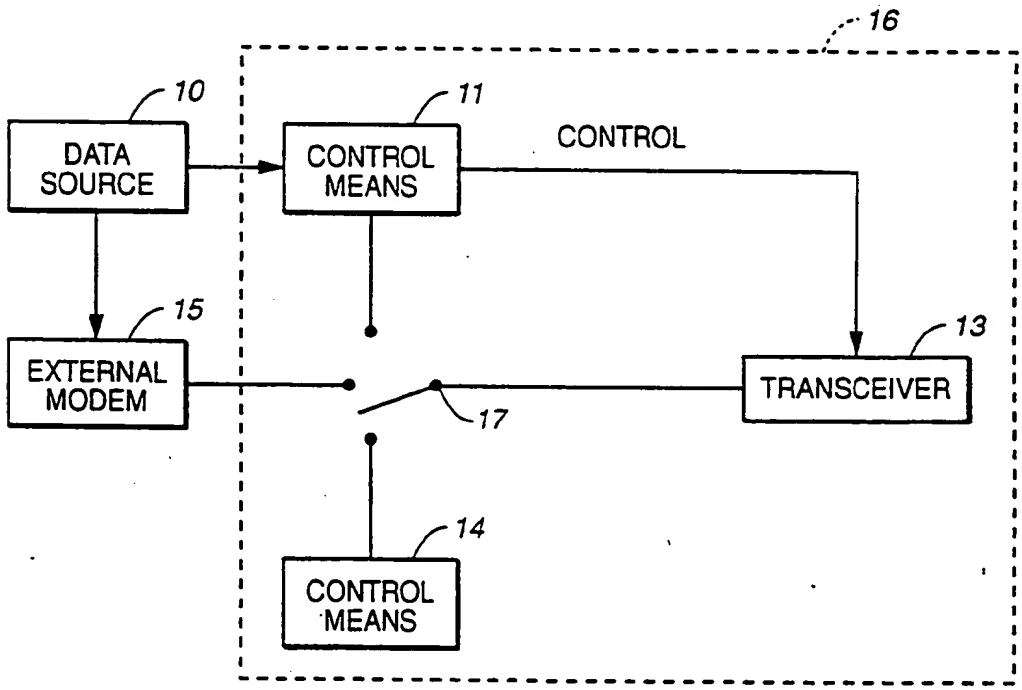
16
10
11
CONTROL
DATA SOURCE
CONTROL MEANS
15
13
EXTERNAL MODEM
TRANSCEIVER
17
14
CONTROL MEANS

FIG._1B

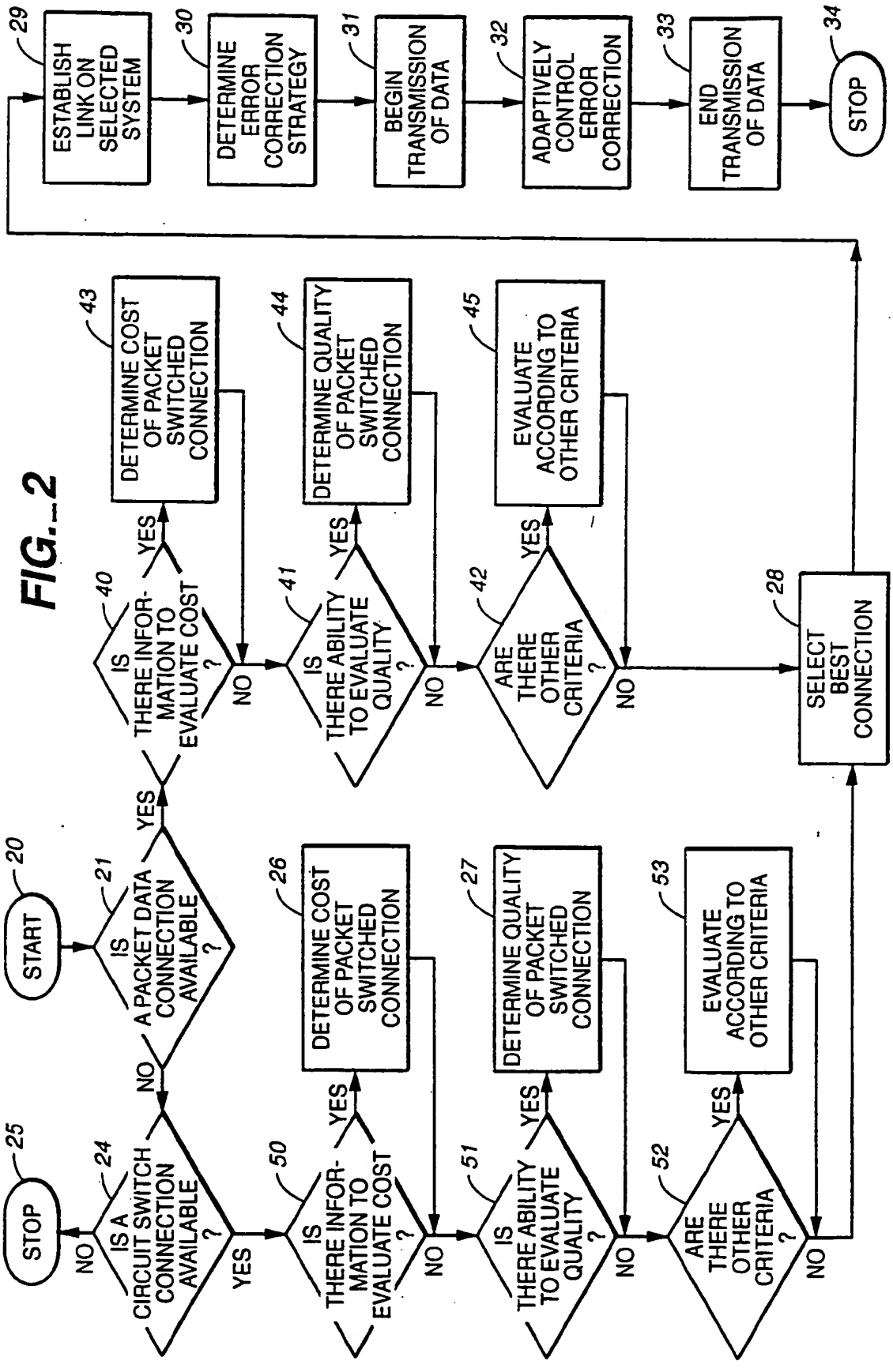
START
20
IS A PACKET DATA CONNECTION AVAILABLE ?
21
YES
NO
IS A CIRCUIT SWITCH CONNECTION AVAILABLE ?
24
YES
NO
STOP
25
IS THERE INFOR-MATION TO EVALUATE COST ?
50
YES
NO
DETERMINE COST OF PACKET SWITCHED CONNECTION
26
IS THERE ABILITY TO EVALUATE QUALITY ?
51
YES
NO
DETERMINE QUALITY OF PACKET SWITCHED CONNECTION
27
ARE THERE OTHER CRITERIA ?
52
YES
NO
EVALUATE ACCORDING TO OTHER CRITERIA
53
IS THERE INFOR-MATION TO EVALUATE COST ?
40
YES
NO
DETERMINE COST OF PACKET SWITCHED CONNECTION
43
IS THERE ABILITY TO EVALUATE QUALITY ?
41
YES
NO
DETERMINE QUALITY OF PACKET SWITCHED CONNECTION
44
ARE THERE OTHER CRITERIA ?
42
YES
NO
EVALUATE ACCORDING TO OTHER CRITERIA
45
SELECT BEST CONNECTION
28
ESTABLISH LINK ON SELECTED SYSTEM
29
DETERMINE ERROR CORRECTION STRATEGY
30
BEGIN TRANSMISSION OF DATA
31
ADAPTIVELY CONTROL ERROR CORRECTION
32
END TRANSMISSION OF DATA
33
STOP
34

FIG._2

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/CA 95/00147

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/22 H04M11/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP,A,0 332 818 (MOTOROLA, INC.) 20 September 1989 see the whole document ---	1-16
Y	CA,A,2 063 901 (NOVATEL COMMUNICATIONS, LTD.) 26 September 1992 see page 2, line 7 - page 5, line 16 ---	1-16
A	EP,A,0 566 957 (RACOTEK, INC.) 27 October 1993 see the whole document --- -/--	1-16

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
9 June 1995	01.06.95

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Goossens, A

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INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/CA 95/00147

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DATA COMMUNICATIONS, vol.22, no.13, 21 September 1993, NEW YORK US pages 23 - 24, XP396757 MILLER 'CDPD Brightens Prospects for Wireless Data' see the whole document	1-16
A	WO,A,91 07044 (INTELLIGENCE TECHNOLOGY CORPORATION) 16 May 1991 see page 3, line 15 - page 5, line 7	1-16

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INTERNATIONAL SEARCH REPORT

Inter. nal Application No
PCT/CA 95/00147

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CA-A-2063901	26-09-92	US-A-	5396539	07-03-95
EP-A-0566957	27-10-93	US-A-	5282204	25-01-94
		AU-B-	3689393	14-10-93
		JP-A-	6120887	28-04-94
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